Acta Medica Okayama

Volume 33, *Issue* 5 1979 *Article* 4

October 1979

Effects of vagotomy on feeding and defecation in guinea pigs.

Toshiaki Neya* Miyako Takai† Sosogu Nakayama‡

*Okayama University,

†Okayama University,

‡Okayama University,

Effects of vagotomy on feeding and defecation in guinea pigs.*

Toshiaki Neya, Miyako Takai, and Sosogu Nakayama

Abstract

The effect of subdiaphragmatic vagotomy on food intake and defecation was studied in guinea pigs. Weights of food and feces were measured for at least three weeks after vagotomy. The weight of daily food intake and feces evacuated increased about 15 and 30% after vagotomy compared with controls whereas it did not change in sham operated animals. The weight of scybalum decreased after vagotomy although the number increased markedly. It was considered that an increase in food intake after vagotomy may result from blocking of satiety signals mediated by the vagus; moreover, that the increase in feces may depend on the enhancement of scybalum formation in the proximal colon resulting from increasing food intake and transportation of the larger amount of the contents after vagotomy.

KEYWORDS: vagotomy, food intake, defecation

*PMID: 160184 [PubMed - indexed for MEDLINE]

Acta Med. Okayama **33**, (5), 371—377 (1979)

EFFECTS OF VAGOTOMY ON FEEDING AND DEFECATION IN GUINEA PIGS

Toshiaki NEYA, Miyako TAKAKI and Sosogu NAKAYAMA

Department of Physiology, Okayama University Medical School, Okayama 700, Japan (Director: Prof. S. Nakayama)

Received March 23, 1979

Abstract. The effect of subdiaphragmatic vagotomy on food intake and defecation was studied in guinea pigs. Weights of food and feces were measured for at least three weeks after vagotomy. The weight of daily food intake and feces evacuated increased about 15 and 30% after vagotomy compared with controls whereas it did not change in sham operated animals. The weight of scybalum decreased after vagotomy although the number increased markedly. It was considered that an increase in food intake after vagotomy may result from blocking of satiety signals mediated by the vagus; moreover, that the increase in feces may depend on the enhancement of scybalum formation in the proximal colon resulting from increasing food intake and transportation of the larger amount of the contents after vagotomy.

Key words: vagotomy, food intake, defecation.

In guinea pigs, the most important mechanism controlling defecation is the intrinsic mucosal reflex, *i.e.*, the activation of myenteric nervous pathway, initiated by distension of the rectal wall with scybala transported into the rectum from the distal colon. Moreover, this intrinsic mucosal reflex is enhanced by excitation of the sacral defecation center. However, the supraspinal center is less important than the spinal center (1, 2). Since the scybalum inducing defecation reflexes is formed by tonic constriction rings in the colon oral to the colonic pacemaking area (the proximal colon) (3), the volume of feces evacuated is apparently dependent on the excitability of the proximal colon.

The vagus nerve controls transportation of the contents of the gastrointestinal tract and proximal colon. Therefore, it influences the volume of feces evacuated in response to a defecation reflex. The vagus also controls daily food intake, feeding time and feeding intervals as well as the gastric emptying rate in rats (4) and rabbits (5).

The following experiment was carried out to study whether the daily volume of feces increases or decreases in vagotomized guinea pigs compared with normal animals, and whether the volume of feces is dependent on the size of food intake.

MATERIALS AND METHODS

Female guinea pigs weighing 350 to 500 g were used. Animals were housed in individual cages (22×40×22 cm) throughout the experimental period. One hundred gram of commercial solid foods (RC 4, Oriental Yeast Co., Chiba, Japan) prepared for both rabbits and guinea pigs was given once a day at 8 : 30 a. m. and animals were allowed to take food and water *ad libitum*.

The meal size and weight of feces for 24 h were measured daily at 8 : 30 a.m. for one week and three weeks before and after vagotomy. The total weight of feces evacuated was estimated as dry weight of feces by desiccation overnight at 40°C. One week after the beginning of the experiment, subdiaphragmatic vagotomy was carried out under pentobarbital anesthesia (35 mg/kg, i.p.). A sham operation was performed to examine the influence of operative injury on feeding and defecation.

The completeness of vagotomy was judged by the results of whether an excitatory response of the stomach to efferent stimulation of cervical vagi was induced or not. In all animals which were vagotomized subdiaphragmatically, no response was obtained by vagus stimulation.

RESULTS

Effect of vagotomy on defecation. Fig. 1 shows an example. The weight of feces evacuated daily was fairly constant. The first day after vagotomy, it decreased to 60% of the control value, then recovered completely on the second day after operation. Thereafter, it increased gradually and on the 10th day, reached about 140% of the control value. The recovery time varied in each animal, but by the 7th day after operation the weight of feces had returned to normal in all of animals.

In all sham operated animals, the changes in weight of feces during the first week after operation were similar to those in vagotomized animals. In contrast to vagotomized animals, no further increase was observed from the second week onward. It appeared that animals recovered from the influence of operative injury within the first week after operation. Therefore, the mean value of the weight of feces evacuated daily was compared every week.

In 4 vagotomized animals, the mean values of the weight of feces were 12.2±1.8 g (mean±S D.) in the control period, and 7.9±4.1, 15.9±2.7 and 16.2±2.9 g in the first, second and third week after vagotomy, respectively. The feces evacuated in the second and third week after vagotomy increased over 30% of those in control. This was a highly significant difference ($p<0.01$). However, in sham operated animals, the weight of feces did not change significantly; that is, the mean values of feces were 13.2±2.3 g in the control period and 12.0±3.2, 14.9±2.9 and 13.8±1.8 g in the first, second and third week after sham operation, respectively.

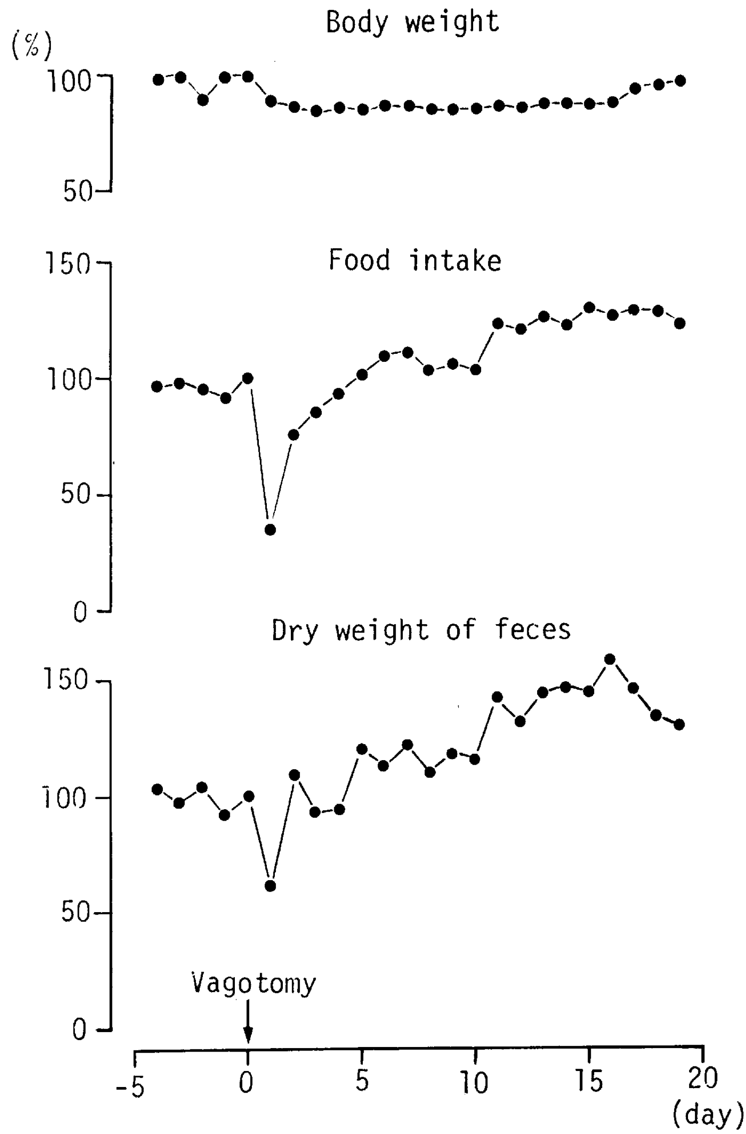

Fig. 1. Daily change of food intake, dry weight of feces and body weight. Each value is shown as the percentage to mean values in control period.

In one of the vagotomized animals, the dry weight of each scybalum evacuated on the 7th day after vagotomy was compared with that before operation. Fig. 2. shows that the weight of an individual scybalum decreased after vagotomy. This means that in vagotomized animals, the size of a scybalum became smaller than in intact animals, but that the number of scybala increased because

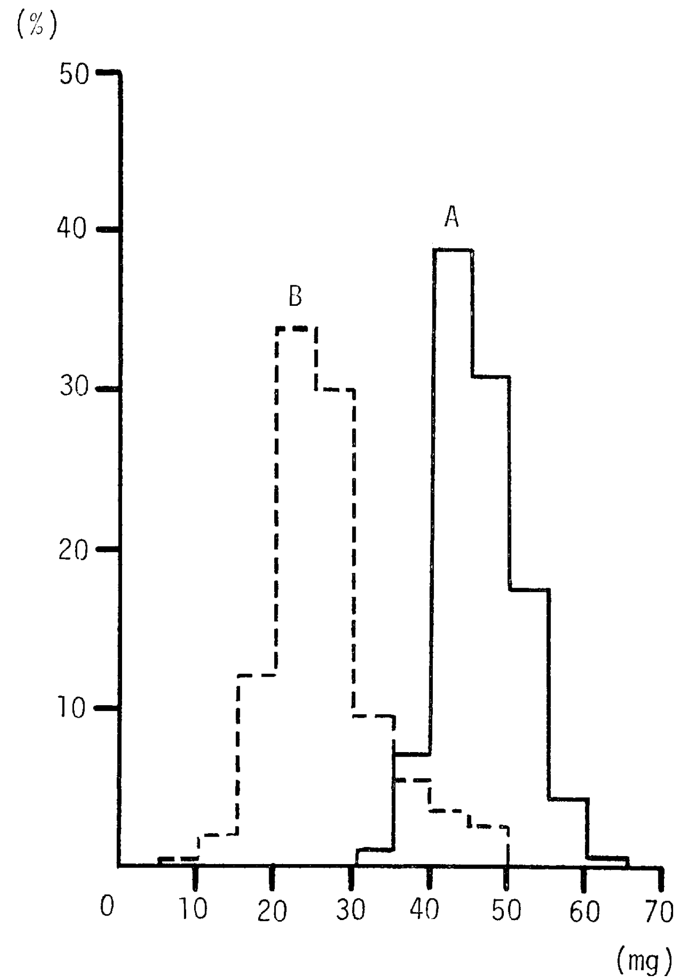

Fig. 2. Histogram of dry weight of a scybalum evacuated in 24 h before and after vagotomy. A: control (n=200); B: on the 7th day after subdiaphragmatic vagotomy (n=553). The peak value of the weight of a scybalum decreased after vagotomy.

the weight of the feces increased after vagotomy compared with the control (Fig. 1).

Effect of vagotomy on feeding. As shown in Fig. 1, the weight of the daily food intake was constant before vagotomy, whereas it decreased to 40% of that in control period on the first day after vagotomy. From the day after, food intake increased gradually and had recovered completely by the 5th day after vagotomy. However, from the 5th day onward, food intake increased over 10% of the control value. In sham operated animals as well as vagotomized animals, food intake markedly decreased on the first day, then recovered within one week after operation. In contrast to vagotomized animals, no further increase in food intake was observed from one week onward.

The mean value of food intake in 4 animals was 35.8±4.9 g before vagotomy. It decreased to 19.9±10.3 g in the first week after vagotomy. In the latter period the volume of feeding fluctuated from day to day in individual animals. In the second and third week the mean values of food intake increased to 40.5±6. 1 g and 41.3±7.3 g, respectively. These values were significantly greater than those before vagotomy ($p<0.01$).

In sham operated animals, the mean values of food intake in one week before and the first, second and third week after operation were 37.7±5.0, 30.5±9.8, 38.2±7.3 and 37.3±6.4 g, respectively. There was no significant difference in the mean values between the pre- and postoperative periods except during the first week after operation.

DISCUSSION

In both vagotomized and sham operated guinea pigs, feeding and defecation acts were markedly depressed and then recovered gradually during the first week after operation; in both animals similar recovery patterns of feeding and defecation were observed during the postoperative period. In vagotomized animals, however, the daily food intake and evacuation of feces increased significantly after recovery, whereas they did not change in sham operated ones. Therefore, for the purpose of studying the vagus effects on feeding and defecation the results obtained one week after operation should be compared with those in the control period. Accordingly, the increase in daily food intake and feces evacuated after recovery resulted from the lack of vagus function. Some satiety signals are mediated, at least in part, by the vagus, because hepatic glucose infusion reduced food intake in intact animals while in vagotomized animals it was without effect (6) and because glucose-sensitive visceral afferents from the hepatic branch of the vagus nerve were found in guinea pigs (7). This suggests, therefore, that the increase in food intake after vagotomy is due to blocking of afferent activity of the vagus nerve.

In contrast to the increse in food intake, the increased evacuation of feces after vagotomy did not relate directly with blocking of the vagus effect on the gastrointestinal tract because defecation occurred without vagal influence but was caused by accerelation of scybala formation in the proximal colon as described below. This is suggested by the fact that the number of scybala defecated after vagotomy increased, although size and weight of a scybalum were smaller and lighter than controls (Fig. 2).

In general, a close relation between the amount of food intake and the volume of feces in intact, sham operated and even in vagotomized animals was observed. When the animals were fasted the volume of feces decreased markedly even though a large amount was left in the cecum, whereas it recovered soon after the animals were fed. Therefore, the volume of feces was dependent on the meal size.

The reason the formation of the scybala was accerelated by vagus transection may be as follows: throughout the gastrointestinal tract the larger amount of contents in vagotomized animals were anally transported compared with controls. Gastric emptying rate of liquid meal increased after vagotomy in rats (4), rabbits (5) and dogs (8). We also observed by X-ray examination that barium meal was more rapidly emptied in vagotomized guinea pigs (unpublished data). As the gastric contents in guinea pigs which took solid food and enough water become liquid-like, the gastric emptying time after vagotomy may decrease.

A sphincteric mechanism controls the transit of gastrointestinal contents. The vagus nerve may play a role, at least in part, of maintaining the tone of the pyloric and ileo-ceco-colonic sphincters. We have frequently noticed that the volume of water emptied from the stomach into the duodenum markdly increases after transection of the vagi although the amplitude of gastric peristalsis does not alter. This indicates that the sphincter relaxes after vagotomy and so the resistance between the stomach and duodenum decreases. This is one of the factors accerelating gastric emptying.

If the vagus nerves are severed, the receptive relaxation of the gastric fundus disappears. This suggests that the intraluminal pressure of the stomach increases with increase in food intake after vagotomy, resulting in accerelation of gastric peristalsis. This may also accerelate gastric emptying. Increased chyme from the stomach into the duodenum may intensify the intrinsic mucosal reflex (9, 10) and so be rapidly transported to the anal intestine. Scybala were formed from chyme by tonic constriction rings occurring in the proximal colon oral to the pacemaker (3). Although the mechanism of initiation of constriction rings is unknown, constriction rings appear more frequently as contents come down into the proximal colon. This is the reason why more scybala were formed after vagotomy compared with before vagotomy. It is considered that the increased frequency of constriction rings may result in smaller but more numerous scybala. These scybala were transported to the distal colon and the rectum over the pacemaking area and were evacuated by a defecation reflex which was elicited in the same manner in both vagotomized and intact animals. Therefore, the daily weight of feces evacuated increased after vagotomy.

It is concluded that an increase in the volume of feces evacuated after vagotomy results from increase of food intake and formation of scybala.

REFERENCES

1. Nakayama, S., Yamasato, T., Mizutani, M., Neya, T. and Takaki, M.: Role of the myenteric plexus in the control of defecation in the guinea pig. In *Integrative Control Functions of the Brain*, Vol. 1, ed. M. Ito, N. Tsukahara, K. Kubota and K. Yagi, Kodansha Scientific, Tokyo, pp. 283-284, 1978.
2. Nakayama, S.: Activity of the spinal defecation center in the guinea pig. *Jpn. J. Smooth Muscle Res.* **14** (Suppl), 33, 1978.
3. Hukuhara, T. and Neya, T.: The movements of the colon of rats and guinea pigs. *Jpn. J. Physiol. Psycol.* **18**, 551-562, 1968.
4. Snowdon, C. T.: Gastrointestinal sensory and motor control of food intake. *J. Comp. Physiol. Psycol.* **71**, 68-76, 1970.
5. Rezék, M., VanderWeele, D. A. and Novin, D.: Stages in recovery of feeding following vagotomy in rabbits. *Behav. Biol.* **14**, 75-84, 1975.
6. Novin, D., Sanderson, J. D. and VanderWeele, D. A.: The effect of isotonic glucose on eating as a function of feeding and infusion site. *Physiol. Behav.* **13**, 3-7, 1974.
7. Niijima, A.: Afferent impulse discharges from glucoreceptors in the liver of the guinea pig. *Ann. N. Y. Acad. Sci.* **157**, 690-700, 1969.
8. Towbin, E. J.: Thirst and hunger behavior in normal dogs and the effect of vagotomy and sympathectomy. *Am. J. Physiol.* **182**, 377-382, 1955.
9. Hukuhara, T., Yamagami, M. and Nakayama, S.: On the intestinal intrinsic reflexes. *Jpn. J. Physiol.* **8**, 9-20, 1958.
10. Hukuhara, T., Neya, T. and Tsuchiya, K.: The effect of the intrinsic mucosal reflex upon the propagation of intestinal contraction. *Jpn. J. Physiol.* **19**, 824-833, 1969.